

Introduction to Physics

Introduction to Physics – Study Notes

1. What Is Physics?

- **Definition** – The scientific discipline that investigates the fundamental constituents of the universe, the forces that act upon them, and the laws that govern their behavior.
- **Scope** – From subatomic particles to galaxies; from static objects to dynamic processes; from everyday phenomena to extreme conditions (e.g., black holes, quantum superposition).
- **Goal** – To develop concise, predictive models that explain observations and enable technological applications.

2. Core Concepts & Terminology

Concept	Meaning	Typical Example
System	The part of the universe chosen for analysis (e.g., a falling ball, an electric circuit).	A block sliding down an incline.
Reference Frame	A coordinate system and set of observers used to describe motion.	Earth-bound frame vs. a spacecraft frame.
Quantity	Measurable property (scalar or vector).	Mass (scalar), velocity (vector).
Unit	Standardized measurement for a quantity (SI system is most common).	Kilogram (kg), meter (m), second (s).
Law	A concise mathematical relationship derived from repeated experiment.	Newton's second law: $\mathbf{F} = m\mathbf{a}$.
Theory	A coherent set of principles that explains a broad range of phenomena and makes testable predictions.	Quantum mechanics, general relativity.

3. Branches of Physics (A Quick Overview)

Branch	Primary Focus	Representative Topics
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Classical Mechanics	Motion of macroscopic objects under forces.	Kinematics, dynamics, conservation laws.
Thermodynamics & Statistical Mechanics	Energy, heat, and the collective behavior of many particles.	Laws of thermodynamics, entropy, kinetic theory.
Electromagnetism	Electric and magnetic fields and their interactions.	Maxwell's equations, circuits, optics.
Optics	Behavior of light.	Reflection, refraction, diffraction, lasers.
Quantum Physics	Behavior of matter and energy at atomic and subatomic scales.	Waveparticle duality, Schrödinger equation, quantum states.
Relativity	Motion at high speeds and gravitation as spacetime curvature.	Special relativity (time dilation), general relativity (black holes).
Condensed Matter	Properties of solids and liquids.	Crystallography, superconductivity, semiconductors.
Particle Physics	Fundamental particles and forces.	Standard Model, Higgs boson, collider experiments.
Astrophysics & Cosmology	Physics of celestial objects and the universe as a whole.	Stellar evolution, cosmic microwave background, dark matter.

4. Fundamental Physical Quantities

Quantity	Symbol	SI Unit	Description
Length	L	meter (m)	Distance between two points.
Mass	m	kilogram (kg)	Measure of inertia.
Time	t	second (s)	Duration of events.
Electric Current	I	ampere (A)	Flow of charge.
Temperature	T	kelvin (K)	Measure of thermal energy.
Amount of Substance	n	mole (mol)	Number of entities (atoms, molecules).

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Quantity	Symbol	SI Unit	Description
Luminous Intensity	I_v	candela (cd)	Perceived power of light.

Derived quantities (e.g., velocity $\mathbf{v}$, acceleration $\mathbf{a}$,